Physics History, 1989: Humanity Glimpses Neptune Up Close
Page 2

Comic: Sensing a Nuclear Kick on a Speck of Dust
Page 3

Recipients of the 2023 5 Sigma Physics Honor
Page 4

Back Page: Why Interdisciplinary Research Deserves Your Attention
Page 6

APS News

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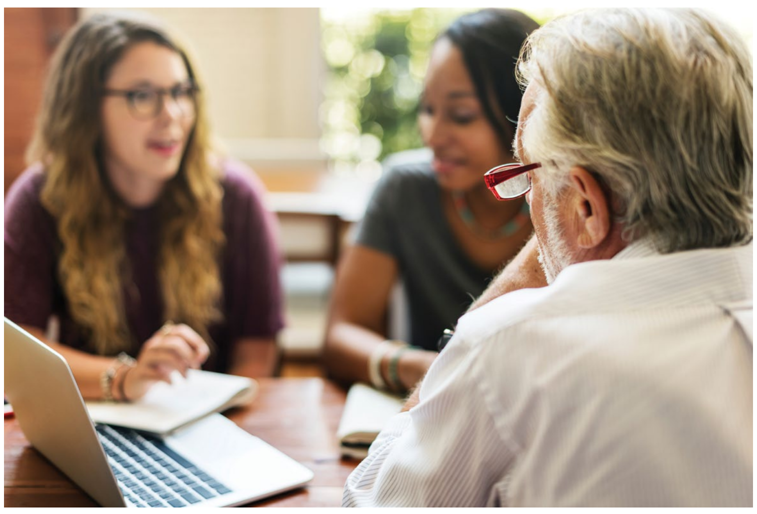
Alleviating the Stress of Finding a Ph.D. Advisor

At many U.S. universities, no formal procedure exists to help physics students pick a Ph.D. project and a supervisor. Researchers argue it's time for that to change.

BY KATHERINE WRIGHT



In the U.S., physics students rarely enter graduate school knowing what specific problem they will study for their Ph.D. or who will supervise them. Rather, sometime during their first year, they will have to search out both while also taking a full docket of high-level coursework. According to graduate-student Mike Verostek of the University of Rochester and the Rochester Institute of Technology in New York, at many institutions this search process occurs with little or no guidance. "It's just up to the student to figure it out," he says.

Now, Verostek and his colleagues show that the haphazard nature of the process can negatively impact the well-being of physics students, particularly those who struggle to immediately find a group. To eliminate uncertainty, the team advocates for a change in the processes by which students find advisors. "Students need more guidance and clearer expectations, and universities need to build formal structures into their programs to support students in finding a project and advisor," Verostek says. "Then they will all succeed."

In the study, published in *Physical Review Physics Education Research*, Verostek and his colleagues interviewed 20 first- and second-year physics graduate students. The students were asked a variety of questions that related to their experience in finding a research group: How easy did they find the process? What guidance were they given? Did they feel that they had enough information to make an informed decision? Verostek and his colleagues also collected data on the students' research experience prior to enrolling in graduate school and on their sense of belonging as Ph.D. students.

The students all described finding a research group as a significant decision, noting that they felt choos-

Ph.D. Advisor continued on page 6

At a Milwaukee Coffee Shop, Enjoy an Espresso. Or a Black Hole.

CoffeeShop Astrophysics, a graduate student-powered outreach program, has shared science in a local cafe since 2014.

BY KENDRA REDMOND

Cafe patrons listen to a talk on the shape and evolution of the universe. CoffeeShop Astrophysics' slogan, "Drink coffee. Talk science," fits well with the group's logo: a black hole spiraling in a cup of joe (with cream, of course). Credit: CoffeeShop Astrophysics/2018

On Saturday afternoons, patrons of Anodyne Coffee Roasting Co. in Milwaukee, Wisconsin, enjoy their double espressos and iced lattes with a dash of astrophysics. Some wander in for caffeine and, curiosity piqued, stick around, while others add CoffeeShop Astrophysics events to their calendars in advance. The program has a 10-year history of serving up science to the community.

It's a fun and enthusiastic crowd to talk to, says Gabe Freedman, a fifth-year Ph.D. student and the program lead. "Maybe they don't have all the right ideas about [science], but that's why you're there," he says. And when people get excited, "you can just feel the enthusiasm radiating off of them."

CoffeeShop continued on page 4

The United Nations Proclaims 2025 as the International Year of Quantum Science and Technology

The declaration recognizes the potential of quantum science to drive innovation.

Flags fly outside the United Nations headquarters in Manhattan, New York, where the U.N. proclamation was announced. Andrew Kazmierski/Adobe

On June 7, the U.N. proclaimed 2025 as the International Year of Quantum Science and Technology (IYQ). This yearlong, worldwide initiative will celebrate the contributions of quantum science to technological progress over the past century, raise global awareness of its importance to sustainable development in the 21st century, and ensure that all nations have access to quantum education and opportunities.

"Through this proclamation, we will bring quantum STEM education and research to young people in Africa and developing countries around the world with the hope of inspiring the next generation of scientists," said Riche-Mike Wellington, Chief Programme Specialist at the Ghana Commission for UNESCO and the Ghanaian representative for IYQ.

Quantum Year continued on page 5

The Astrophysicist Restoring Ecosystems to Combat Climate Change

Meet Claire Burke, the head of applied science at a land regeneration startup.

BY RACHEL CROWELL

Claire Burke

When Claire Burke decided to study physics, she knew it could open many doors. "You can do almost anything with a physics degree," Burke recalls hearing. But even Burke didn't expect that her Ph.D. in astrophysics would lead her to her work today: land regeneration.

"What Zulu Ecosystems sells is restored landscapes," Burke says. "So, they actually restore ecosystems." The firm works with landowners to restore degraded land, including corporate entities who often invest in carbon sequestration by buying carbon credits.

As the head of applied science at Zulu Ecosystems, a U.K.-based startup, Burke leads a team that crisscrosses disciplines. Through her astrophysics training and the roles she has held since earning her Ph.D., she has gained expertise in remote sensing, data science, machine learning, climate science, and science communication.

At the start of the land restoration process, "You look at a piece of land and kind of say, 'What does this land want to be? And what is it now?" Burke says. A plot that's currently used for farming might have soil, water, or ecological traits indicative of wetland, for example.

The science behind the work spans physics, biology, ecology, and beyond. That suits Burke, whose career has been diverse. "I've never really known what I wanted to be when I grew up," she says.

Burke's career began in astrophysics, where she studied galaxy clusters. But during her first postdoctoral work in the field, she became "a little bit frustrated" with academia, she says. She credits her mother for planting the seed of an idea that would shape her future: "Maybe I didn't have to do astrophysics for my entire career."

She looked further afield. After learning that "the meat industry produces more carbon than the transportation sector," which wasn't common knowledge at the time, she sought a way to make an impact.

She became a climate scientist for the Met Office, the United Kingdom's national weather and climate service. "Everything on the job description was the same stuff I did in astrophysics, but looking down instead of looking up," Burke says. In that role, she studied the relationship between extreme rainfall and climate change.

Later, she spotted a unique opportunity for a second postdoc at Liverpool John Moores University in the U.K., where she had earned her doctorate. There, an astrophysicist and a conservation ecologist had started a research team called, appropriately, Astro-Ecology, which aimed to borrow imaging techniques from astronomy to support conservation efforts. With Burke on board, the team designed drones outfitted with thermal-infrared cameras to monitor wildlife, and then developed AI-based software capable of determining an animal's species from its thermal data.

The team used their equipment in Borneo to spot wild orangutans — no small feat. "The physics says that we should be able to see the orangutans," she recalls thinking, but since orangutans live in dense, humid rainforest, that meant "try-

Claire Burke continued on page 4

US Lawmakers Propose Barring Chinese and Russian Citizens From DOE Labs

The Biden administration has objected to the proposal.

BY MITCH AMBROSE

The Senate Intelligence Committee is proposing to prohibit citizens of China and Russia from accessing Department of Energy national labs unless they have permanent residence status in the U.S. or secure a waiver. The proposal is contained in the Intelligence Authorization Act that the committee voted unanimously in May to advance to the full Senate for consideration. The prohibition would also apply to citizens of Iran, North Korea, and Cuba.

The legislation states that while "international cooperation in the field of science is critical to the United States maintaining its leading technological edge," the DOE lab system "is increasingly targeted by adversarial nations to exploit military and dual-use technologies for military or economic gain."

The restriction was added to the legislation through an amendment by Sen. Marco Rubio (R-FL), the top Republican on the committee. "This bill takes unprecedented steps to address counterintelligence risks to our national laboratories by prohibiting visitors from foreign adversary nations thereby protecting America's research and competitive advantage," Rubio said in a statement.

The House Intelligence Committee's version of the legislation does not contain the proposal, but the House included a narrower prohibition in the version of the annual National Defense Authorization Act it sent to the Senate in June. That provision would prohibit any "citizen or agent" of China and Russia from visiting non-public areas of DOE security labs unless they are a permanent resident of the U.S. or secure a waiver.

> The Biden administration has objected to Lamborn's latest proposal on the grounds it would "severely limit our ability to engage with Chinese and Russian experts on nonproliferation of biological, chemical, and nuclear weapons."

It also states that more than 8,000 citizens from China and Russia were granted access to DOE national labs in fiscal year 2023, out of around 40,000 foreign users of the labs. Many of these visits presumably were to the labs' scientific user facilities, which DOE historically has made available to external researchers.

DOE is pushing back against the proposed restriction. "This proposal would have a significant impact on our national laboratories," a DOE spokesperson said. "DOE is working with the Senate Intelligence Committee and other congressional offices to provide information about the role of foreign nationals in the department's overall scientific enterprise and more broadly, the nation's global economic competitiveness."

The provision is authored by Rep. Doug Lamborn (R-CO), the top Republican on the House subcommittee that oversees DOE's National Nuclear Security Administration, which funds Los Alamos, Lawrence Livermore, and Sandia National Labs.

Lamborn expressed concern about the Biden administration's idea of inviting representatives of China and Russia to visit testing facilities that DOE uses to maintain the integrity of U.S. nuclear weapons.

"Proponents of this policy argue that inviting foreign observers to view our tests would encourage our

DOE Labs continued on page 4

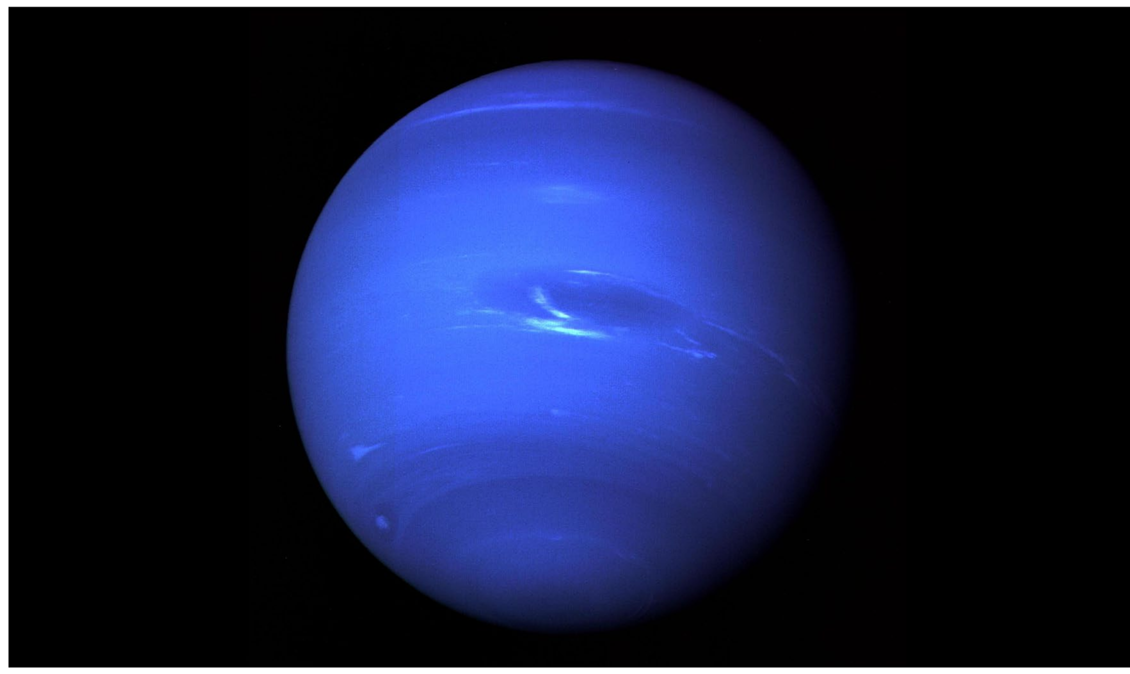
A summer storm over Los Alamos National Laboratory, a DOE national lab. Credit: Los Alamos National Laboratory

THIS MONTH IN PHYSICS HISTORY

Aug. 25, 1989: Humanity Glimpses Neptune Up Close

Voyager 2 became the first spacecraft to probe the Solar System's mysterious ice giants.

BY KENDRA REDMOND



Neptune, with its Great Dark Spot and high-altitude clouds visible, as captured by Voyager 2 in 1989 from 4.4 million miles away. Credit: NASA/JPL

In the 1820s, French astronomer Alexis Bouvard noticed something unusual: The planet Uranus was behaving oddly, its predicted positions out of sync with observation. Could something be tugging on it? French and British scientists rushed to calculate the position of this unknown body, and in 1846, Neptune, the farthest planet from the sun, was finally observed.

But for more than a century afterward, Neptune remained mostly a mystery, a tiny disc in telescope images — until 1989, when Voyager 2 became the first and only spacecraft to complete a flyby of the Blue Giant, introducing humanity to its most distant planetary neighbor and shaping astronomy in the process.

Neptune long presented a challenge for scientists. Some 4.3 billion kilometers away from Earth at its closest point, it was simply too far away to study easily. "By comparison with other planets, progress in understanding physical properties of Neptune and its satellite Triton was extremely slow," write astronomers Clark Chapman and Dale Cruikshank in the compilation *Neptune and Triton*.

But in the 1960s, Gary Flandro, a Caltech graduate student working at NASA's Jet Propulsion Laboratory (JPL), realized that, over the next two decades, a rare planetary arrangement would take place. Jupiter, Saturn, Uranus, and Neptune would be optimally positioned for spacecraft visits, thanks to gravitational assists that could slingshot a probe from one planet to another — and the window only opened every 175 years.

NASA initially proposed sending four spacecraft to the four planets, but the cost was a sticking point, and Congress asked for a more modest plan. The revised project, Voyager, would send two spacecraft to Jupiter and Saturn. But the team, based at JPL in southern California, left the back door open. If Voyager 2's mission was later extended, the probe could head to Uranus and then Neptune.

NASA launched Voyager 1 and Voyager 2 in 1977. By the end of 1980, both had completed their missions, revealing the two gas giants, Saturn and Jupiter, to the world. On the heels of this success, Congress approved funding to extend Voyager 2's mission.

JPL scientists quickly reprogrammed the path of the spacecraft. It would take 4.5 years to reach Uranus and another 3.5 years to reach Neptune, but there was much to do. Experts formed working groups, identifying key images and data-collecting measures for the atmospheres, rings, satellites, and magnetospheres of the ice giants.

> "The experience of the entire 12-year mission of Voyager 1 and 2 is that we never are smart enough to predict what we're going to see." — Carl Sagan

In 1986, after Voyager 2 completed the first (and only) flyby of Uranus, all eyes turned to Neptune.

Information was scarce. "It was almost embarrassing how little was actually known about the planet and its system," wrote Voyager 2 scientist Ellis Miner and engineer Randii Wessen in the book *Neptune: The Planet, Rings, and Satellites*. "The rotation period of Neptune was little more than an estimate, and there was no direct knowledge of the nature of the magnetic and associated radiation fields," they wrote. "There were only tantalizing indications that Neptune possessed rings, and only the barest of information existed on its two known satellites."

As planetary scientists debated a flyby path and research aims, others worked on the technical challenges. The Earth-based Deep Space Network of antennas received Voyager 2's transmissions, but Neptune's distance was a problem. The receivers would need more listening time to capture the faint signals, which meant reducing the probe's transmission rate. To compensate, NASA expanded some antennas and recruited more, including in California, New Mexico, Australia, and Japan.

Meanwhile, other JPL scientists remotely reprogrammed and reconfigured Voyager 2's computer systems. They gave backup computers new roles and adjusted techniques to accommodate low light levels and transmission rates. "The Voyager 2 that passed Neptune was a much better spacecraft than the Voyager that encountered Uranus," wrote Miner and Wessen.

By June 1989, Voyager was sending near-constant images of Neptune back to Earth. With each passing day, the small, fuzzy dot grew larger in the images, which loaded line by line in the control room. "Voyager, Heading Toward Neptune, Sights 3 Undiscovered Moons," ran the *New York Times* on Aug. 4. On Aug. 20, "Voyager Cameras Discover a Turbulent Blue Neptune." Data on

Neptune continued on page 5

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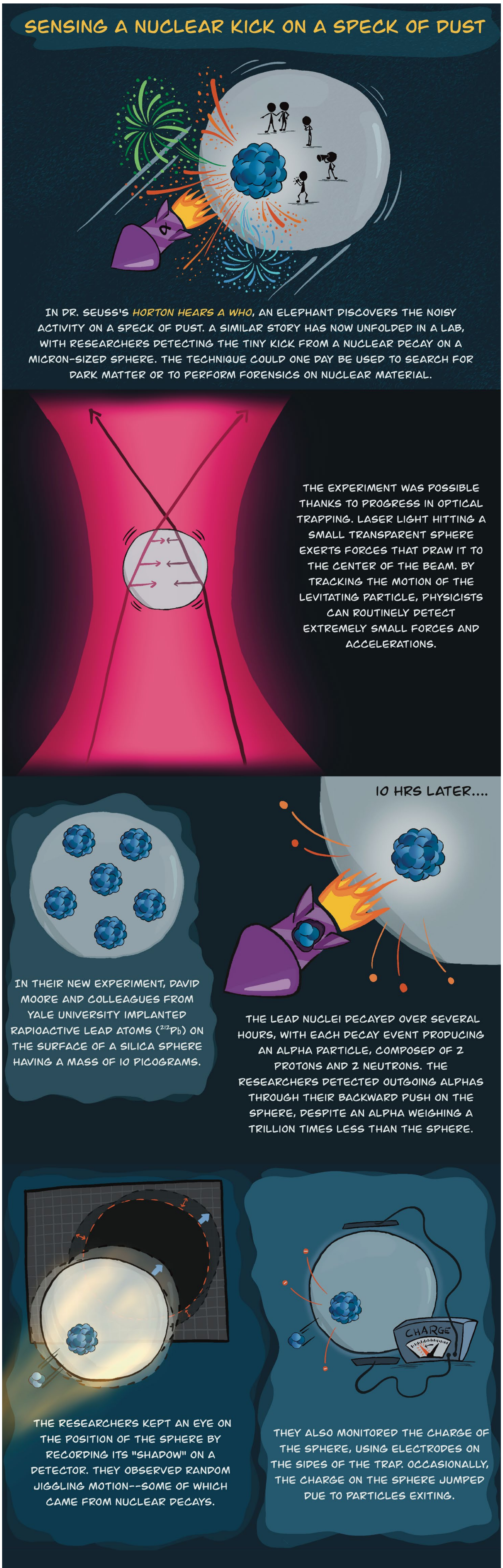
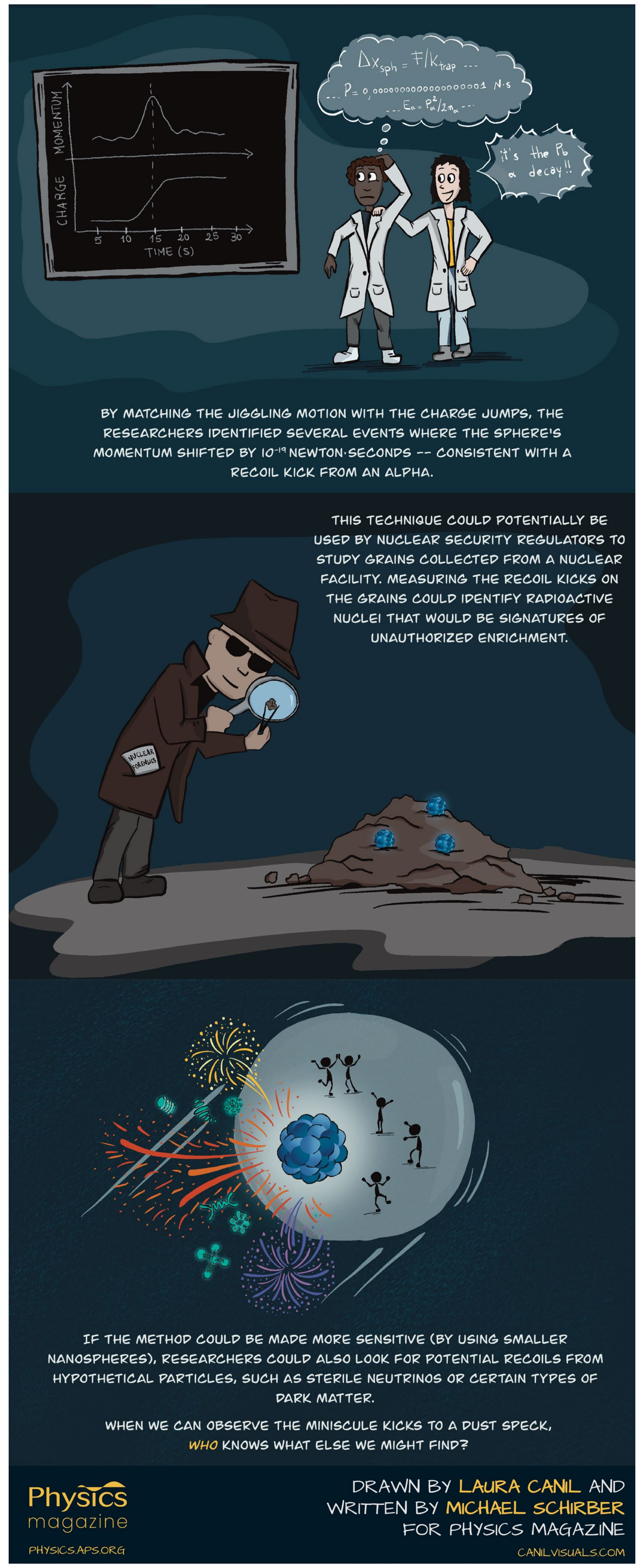

SENSING A NUCLEAR KICK ON A SPECK OF DUST
IN DR. SEUSS'S *HORTON HEARS A WHO*, AN ELEPHANT DISCOVERS THE NOISY ACTIVITY ON A SPECK OF DUST. A SIMILAR STORY HAS NOW UNFOLDED IN A LAB, WITH RESEARCHERS DETECTING THE TINY KICK FROM A NUCLEAR DECAY ON A MICRON-SIZED SPHERE. THE TECHNIQUE COULD ONE DAY BE USED TO SEARCH FOR DARK MATTER OR TO PERFORM FORENSICS ON NUCLEAR MATERIAL.
THE EXPERIMENT WAS POSSIBLE THANKS TO PROGRESS IN OPTICAL TRAPPING. LASER LIGHT HITTING A SMALL TRANSPARENT SPHERE EXERTS FORCES THAT DRAW IT TO THE CENTER OF THE BEAM. BY TRACKING THE MOTION OF THE LEVITATING PARTICLE, PHYSICISTS CAN ROUTINELY DETECT EXTREMELY SMALL FORCES AND ACCELERATIONS.
10 HRS LATER....
IN THEIR NEW EXPERIMENT, DAVID MOORE AND COLLEAGUES FROM YALE UNIVERSITY IMPLANTED RADIOACTIVE LEAD ATOMS (^{212}Pb) ON THE SURFACE OF A SILICA SPHERE HAVING A MASS OF 10 PICOGRAMS.
THE LEAD NUCLEI DECAYED OVER SEVERAL HOURS, WITH EACH DECAY EVENT PRODUCING AN ALPHA PARTICLE, COMPOSED OF 2 PROTONS AND 2 NEUTRONS. THE RESEARCHERS DETECTED OUTGOING ALPHAS THROUGH THEIR BACKWARD PUSH ON THE SPHERE, DESPITE AN ALPHA WEIGHING A TRILLION TIMES LESS THAN THE SPHERE.
CHARGE
THE RESEARCHERS KEPT AN EYE ON THE POSITION OF THE SPHERE BY RECORDING ITS "SHADOW" ON A DETECTOR. THEY OBSERVED RANDOM JIGGLING MOTION--SOME OF WHICH CAME FROM NUCLEAR DECAYS.
THEY ALSO MONITORED THE CHARGE OF THE SPHERE, USING ELECTRODES ON THE SIDES OF THE TRAP. OCCASIONALLY, THE CHARGE ON THE SPHERE JUMPED DUE TO PARTICLES EXITING.


MOMENTUM
CHARGE
5 10 15 20 25 30
TIME (S)
it's the Pb α decay!!
BY MATCHING THE JIGGLING MOTION WITH THE CHARGE JUMPS, THE RESEARCHERS IDENTIFIED SEVERAL EVENTS WHERE THE SPHERE'S MOMENTUM SHIFTED BY 10^{-19} NEWTON·SECONDS -- CONSISTENT WITH A RECOIL KICK FROM AN ALPHA.
THIS TECHNIQUE COULD POTENTIALLY BE USED BY NUCLEAR SECURITY REGULATORS TO STUDY GRAINS COLLECTED FROM A NUCLEAR FACILITY. MEASURING THE RECOIL KICKS ON THE GRAINS COULD IDENTIFY RADIOACTIVE NUCLEI THAT WOULD BE SIGNATURES OF UNAUTHORIZED ENRICHMENT.
IF THE METHOD COULD BE MADE MORE SENSITIVE (BY USING SMALLER NANOSPHERES), RESEARCHERS COULD ALSO LOOK FOR POTENTIAL RECOILS FROM HYPOTHETICAL PARTICLES, SUCH AS STERILE NEUTRINOS OR CERTAIN TYPES OF DARK MATTER.
WHEN WE CAN OBSERVE THE MINISCULE KICKS TO A DUST SPECK, *WHO* KNOWS WHAT ELSE WE MIGHT FIND?
Physics magazine
PHYSICS.APS.ORG
DRAWN BY LAURA CANIL AND WRITTEN BY MICHAEL SCHIRBER FOR PHYSICS MAGAZINE
CANILVISUALS.COM

CoffeeShop continued from page 1

CoffeeShop Astrophysics celebrated its 10th anniversary in April 2024. Credit: CoffeeShop Astrophysics/2024

The public engagement program is run by graduate students from the University of Wisconsin, Milwaukee's Center for Gravitation, Cosmology, and Astrophysics (CGCA). Each event features a 45-minute talk, co-presented by two or three grad students, and a Q&A session.

Many public engagement programs feature scientists talking about their own research, but CoffeeShop follows a different model. Each semester, the group of 10 or so graduate students selects broadly appealing topics to highlight, then divides into smaller groups to write and present the talks, Freedman says. This lightens the load and facilitates collaborative efforts where, for example, more experienced presenters can mentor new ones. The group also meets for run-throughs to give presenters feedback before they talk at Anodyne.

Why a coffee shop?

"It's easy with physics to intimidate people really fast," says CoffeeShop founder Sydney Chamberlin. When she started the program in 2014, she prioritized an inclusive and accessible meeting space to lower the intimidation factor — which meant going off-campus. A friend connected her to the manager of Anodyne, a local coffee shop with a cafe in a historic city neighborhood, and the longstanding partnership began.

The cafe is cozy, complete with wood floors and ceiling, cream-colored brick, and mellow string lights — just the right setting, it seems, for discussion topics like "How Empty is Space?" and "The Universe is Not Real."

Chamberlain never imagined that CoffeeShop would outlast her time at UW-Milwaukee. It all started when she wrote a proposal to the APS Physics on the Road program (a precursor to the current FOEP Mini-Grants), securing a $1,500 award to fund five outreach events. She and fellow graduate students brainstormed topics, broke them into bite-sized pieces on colorful sticky notes, and worked together to create talks.

"We weren't sure it was going to be successful in any way," she says. But the enthusiasm, venue, and compelling topics — like "The Black Hole that Ate My Sock" — worked. The audience soon outgrew Anodyne's back room, and CoffeeShop Astrophysics moved into the main event space. Today, events typically draw 50 to 100 people, sometimes more.

Chamberlain graduated in 2015, moving on to a postdoc and a career in climate policy and conservation at the Nature Conservancy. But other graduate students picked up where she left off, weaving CoffeeShop into the fabric of the CGCA graduate student experience, even during the COVID-19 pandemic lockdown. When coffee shops and gathering places shuttered, CoffeeShop members recorded talks in their apartments and posted them online. And when doors reopened, they recruited new members, like Lulu Agazie, to give in-person talks.

Agazie started grad school at UW-Milwaukee in 2020 and spent the majority of her first year holed up in her apartment. When restrictions lifted, she joined the outreach program. "CoffeeShop was one of the first ways I started getting involved in the community," she says. Now in her fourth year, she credits the program with helping her build relationships with fellow grad students, meet people in Milwaukee, and develop strong communication skills, especially when it comes to breaking down complex ideas for nonscientists.

The program is still entirely student-run, fueled by passion, camaraderie, and mochas. There's a risk to that — graduation. "CoffeeShop is sustainable for one primary reason," says Freedman. "The students that are passionate about it and that get involved." He can't guarantee what will happen when he graduates, but says that "as long as there are some people who are engaged in it, CoffeeShop will continue."

In April, the team celebrated CoffeeShop's 10-year anniversary with a reception and guest talks by Chamberlin and other former leaders. Casey McGrath, a former program leader, reflected on what kept him going. "These people want to be here; this is their best use of their time," he recalled thinking. "Let's keep doing this."

Chamberlin, for her part, is thrilled with the program's success and that so many graduate students have found the program rewarding. "I know there was a period, especially near COVID, where it was challenging. And I know there have been stretches in the program where one graduate student really carried the baton," she says. "It's crazy and mind-boggling and exciting that 10 years later, it is still going strong."

Kendra Redmond is a writer based in Minnesota.

Eighteen Science Policy Advocates Receive 2023 5 Sigma Physics Honor

Recipients demonstrated substantial, impactful advocacy actions.

BY TAWANDA W. JOHNSON

Mehmet Dogan, a physicist originally from Turkey, knows how difficult it is to get a visa to work in STEM in the United States.

After he received his doctorate in the U.S., he "had to go from visa to visa for years, leading to uncertainty, missed opportunities, and an overall career delay," says Dogan, who works as a technical advisor at a law firm, Ropes & Gray LLP.

This experience made him excited to partner with APS staff to advocate for the Keep STEM Talent Act, legislation that would provide a pathway for permanent residency to international students and scholars with advanced STEM degrees from U.S. institutions.

"Advocating for this and similar reforms is hugely important to me as a person," he says.

APS recently awarded Dogan and 17 other APS members with the 5 Sigma Physicist Honor for outstanding science policy advocacy in 2023. Recipients demonstrated substantial, impactful advocacy actions with APS Government Affairs. Besides Dogan, the honorees are Timothy Atherton, Ramón Barthelemy, James Bowen, Wouter Deconinck, Michael Falk, Scott Franklin, Savannah Garmon James Isenberg, Elena Long, Tucker Manton, Arantxa Pardue, Kyle Reeves, Robert Rosner, Elizabeth Simmons, David Strubbe, James Vary, and Wennie Wang.

APS staff figured the Keep STEM Talent Act would be of interest to members of the Society's Forum on Early Career Scientists (FECS). So they partnered with the forum on a grassroots email campaign, which Dogan, the forum's 2021 international affairs officer, supported. The campaign inspired 153 advocates to send 423 messages to Congress. APS staff also held a training for the forum's executive committee leadership on the specifics of the legislation and provided tips on scheduling and meeting with members of Congress.

"I had the full support and participation of FECS in my efforts," Dogan says, and APS Government Affairs "made it extremely easy to collect and submit letters and contact policymakers."

Besides the Keep STEM Talent Act, the honorees advocated for the Noyce Scholars Program, Methane Emissions Mitigation Research and Development Act, LGBTQI+ Data Inclusion Act, and federal funding for science research and development.

Research funding is an important issue for honoree James Isenberg, professor emeritus at the University of Oregon whose work centered on gravitational physics and geometric analysis. He has been a "very proud recipient" of funding from the National Science Foundation for more than 40 years.

"Personally, without that NSF research support, my scientific and mathematical career would have been diminished," he says.

Isenberg said while he had written op-eds in the past, he hadn't thought much about contacting Congress. This changed after he received an email from Charlotte Selton, APS member advocacy senior associate, about signing up for an advocacy webinar.

"I participated in that, and subsequently, Charlotte discussed with me very practical tips on how to best proceed individually with advocacy for science," he says — tips, he adds, he was able to apply in his own advocacy work, including crafting emails to his elected officials and communicating effectively in virtual congressional meetings.

Tawanda W. Johnson is APS's senior public relations manager.

Claire Burke continued from page 1

ing to detect heat somewhere that's already quite hot."

Nevertheless, they succeeded in correctly finding and identifying the orangutans, making the project a "strong proof of concept," she says.

When her postdoc ended, Burke considered continuing her career at a university, but she faced a challenge. "The academic world is very siloed — you're a biologist or you're a geographer or you're a physicist," she says. "I was sitting in between all these different disciplines." So, for the next few years, she deepened her experience at a handful of private-sector companies with missions rooted in climate and environmental science before landing at Zulu Ecosystems.

In her role today, "I have to be able to see where the business is going next," Burke says. She leads an interdisciplinary team, figuring out promising and potentially profitable pursuits and assessing her team's capacity to execute them. When needed, she recruits additional researchers with complementary expertise, either hiring team members or developing new partnerships with university faculty.

After an initial project stage where the team evaluates the types of ecosystems best suited for a particular plot of land, Burke and her colleagues present a client with different options for land restoration, including the costs and potential benefits — each backed by rigorous scientific analysis. The company's software platform enables clients to explore these detailed options, helping them "make decisions and choices about what sort of things [they] want to do with a piece of land," she says. Once a project is scoped and solidified, the firm carries out the restoration work from beginning to end.

What advice does Burke have for a physicist wanting to pursue a new career direction? "Do the things that interest you and excite you," Burke says. "There are places you can apply your skills that you'd be surprised by."

For early-career researchers looking to transition from academia to industry, Burke suggests highlighting in your resume and interviews "your skills, rather than the papers you have written." Those transferable manuscripts from grad school? "An employer will not have a clue," she says.

> **With Burke on board, the team designed drones outfitted with thermal-infrared cameras to monitor wildlife, and then developed AI-based software capable of determining an animal's species from its thermal data.**

But the skills are transferable. "Can you program? Can you solve problems? Can you communicate a complicated subject to a non-technical audience?" she asks. Those are important to many employers.

With some hard work, a rewarding career in industry could be around the corner, as Burke has learned firsthand. "I talk to a lot of people," she says. "I get to think some very big thoughts about how we can solve unsolvable problems."

Rachel Crowell is a science and math writer based in Iowa.

DOE Labs continued from page 2

adversaries to be more transparent about their activities," Lamborn remarked when advocating for a version of his proposal that he advanced last year. "However, China and Russia have had ample opportunity to be more open about their nuclear weapons development and deployments and refuse to do so. So, allowing adversaries to observe our nuclear testing activities is allowing them to derive our methods and procedures, and this destroys deterrence."

The Biden administration has objected to Lamborn's latest proposal on the grounds it would "severely limit our ability to engage with Chinese and Russian experts on nonproliferation of biological, chemical, and nuclear weapons."

"The existing visitor-screening process at the national laboratories and nuclear weapons production facilities are specifically designed to screen for visitor threats and prevent access to protected information," the administration added.

This position suggests the administration will also push back on the proposal from the Senate Intelligence Committee.

Mitch Ambrose is the director of science policy news at the American Institute of Physics.

APS Selects Ryan Nesselrodt as 2024-25 Congressional Science Fellow

Nesselrodt will work with congressional leaders and staff for a year.

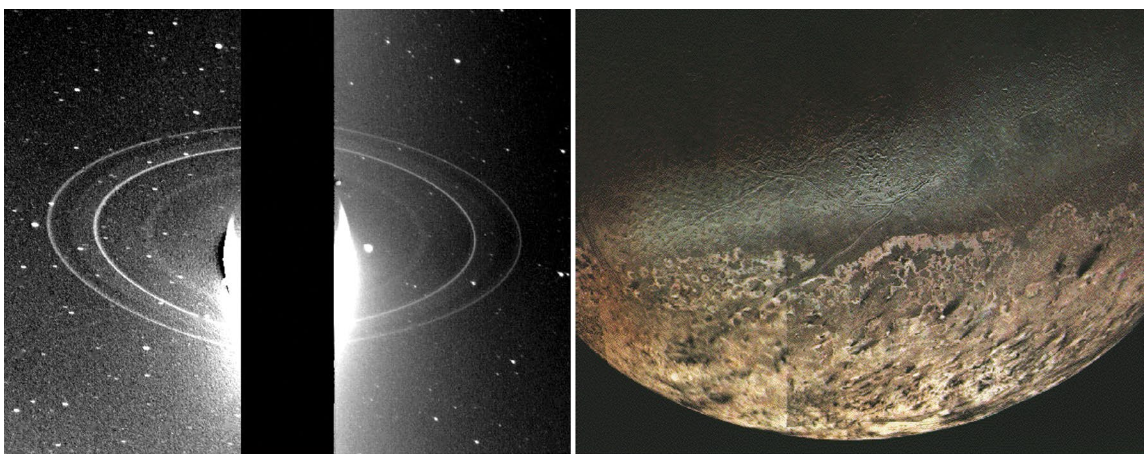
APS is thrilled to announce the 2024-25 Congressional Science Fellow, Ryan Nesselrodt. He earned his doctorate and master's degrees in physics from Georgetown University in 2023 and 2019, respectively, and his bachelor's degree in physics and mathematics from Franklin & Marshall College in 2017. Nesselrodt recently served as a West Virginia Science and Technology Policy Fellow.

Ryan Nesselrodt

APS sponsors the fellowship under the umbrella of the American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowships to make individuals with scientific knowledge and skills available to members of Congress, few of whom have technical backgrounds.

In turn, the fellowship enables scientists to broaden their experience through direct involvement with the policymaking process. Fellows work directly with congressional leaders and staff for a year, usually from September to August. As part of the fellowship, they complete a two-week orientation in Washington, D.C., interview on Capitol Hill, and then choose a congressional office or committee.

Neptune continued from page 2



Neptune's rings (left) and the surface of Triton, Neptune's largest moon — both captured by Voyager 2. Credit: NASA/JPL

the planet's atmospheric composition, magnetic field, and ring composition flowed in.

In late August, as the day of Voyager's closest approach drew nearer, excitement intensified. Daily press conferences kicked off days beforehand. Team members slept and showered at work rather than going home, congregating around monitors as new pictures came in.

On Aug. 24, project scientist Edward Stone told the *New York Times*, "This is the 24 hours we've been waiting for." At 9 p.m. PT (4 a.m. on Aug. 25 GMT), Voyager 2 passed within 5,000 kilometers of Neptune. The images reached Earth 4 hours and 6 minutes later.

They revealed a dizzying array of discoveries. Over its tour, the probe photographed five new moons and verified another, bringing the number of confirmed moons to eight (the total known today is 13). Other images showed five distinct rings; previously, it was thought that Neptune had only ring fragments. It photographed Neptune's Great Dark Spot, an Earth-sized storm whose winds reach speeds of 2,000 kilometers per hour. Methane clouds cast visible shadows on the atmosphere below.

During a "Live From JPL" CNN special, the host asked Carl Sagan, who was part of the imaging team, if he had been surprised by anything in the Neptune images. "The experience of the entire 12-year mission of Voyager 1 and 2 is that we never are smart enough to predict what we're going to see," he answered.

After completing its flyby of Neptune, Voyager 2 turned toward Triton, Neptune's largest moon, a frigid place sheathed in nitrogen ice. The probe collected data for a few days before setting out on a new and ongoing adventure: exploring the interstellar medium until it runs out of power.

Voyager's planetary tour had ended, but the analysis had just started. The data began to merge into a rich, detailed picture of Neptune's dynamic atmosphere, internal processes, and ring structure. Measurements constrained models of ice giant formation and evolution, with applications for understanding exoplanets. The planet's tilted magnetic field convinced scientists that Uranus' similarly oriented field was likely a characteristic of an interior process, not an anomaly. Triton proved to be especially intriguing, with its captivating geologic history and an inclined, retrograde orbit.

The Hubble Space Telescope, the Webb Telescope, and powerful Earth-based telescopes have added to our knowledge, but no spacecraft have visited Uranus or Neptune since Voyager 2.

A year after the Neptune flyby, Sagan reflected on Voyager 2's discoveries and humanity's achievements at a NASA press conference. "We humans have completed the preliminary reconnaissance of the solar system," he said. "There's only one time in history this happens — when, for the first time, humans send their artifacts and themselves off the earth and explore their local neighborhood in space."

Kendra Redmond is a writer based in Minnesota.

Engineers at the Jet Propulsion Laboratory work on the Voyager 2 in March 1977, ahead of its launch later that year. Credit: NASA/JPL

Quantum Year continued from page 1

IYQ coincides with the 100th anniversary of the birth of modern quantum mechanics, the theory that describes the behavior of matter and energy at atomic and subatomic scales and that has made possible many of the world's most important technologies. Over the past century, quantum theory has become foundational to physics, chemistry, engineering, and biology and has revolutionized modern electronics and global telecommunications. Inventions like the transistor, lasers, rare-earth magnets, and LEDs — technologies that brought the internet, computers, solar cells, MRI, and global navigation into fruition — all exist because of quantum mechanics.

Advances in quantum applications could enable new computing and communication models with the potential to accelerate innovations in materials science, medicine, and cybersecurity, among other fields. In this way, quantum science and technology is poised to help address the world's most pressing challenges — including the need to rapidly develop renewable energy, improve human health, and create global solutions in support of the U.N.'s Sustainable Development Goals.

"This second quantum revolution is leading to breakthroughs in using quantum effects like superposition and entanglement for new applications," said John Doyle, Henry B. Silsbee Professor of Physics at Harvard University, co-director of the Harvard Quantum Initiative, and president-elect of the American Physical Society. "When these phenomena can be applied broadly to control and engineer matter at the level of single quanta, and even single atoms, they will spark transformations in a multitude of technologies."

The U.N. proclamation is the culmination of a multiyear effort spearheaded by an international coalition of scientific organizations. After Mexico shepherded the coalition's initial proposal through UNESCO's 42nd General Conference in November 2023, Ghana formally submitted a draft resolution to the U.N. General Assembly in May 2024 that garnered co-sponsorship from more than 70 countries before its approval today.

UNESCO will oversee the campaign as the U.N.'s lead agency, while the American Physical Society will administer the campaign through an international consortium and invite scientific societies, academic institutions, philanthropic organizations, and industry to contribute to the initiative. The consortium's current founding partners include APS; the German Physical Society; the Chinese Optical Society; SPIE, the international society for optics and photonics; and Optica.

"The American Physical Society welcomes the opportunity to collaborate with scientific organizations from around the world to spread awareness about quantum science and technology," said Jonathan Bagger, the CEO of APS. "With worldwide events and programming, we hope to build a vibrant and inclusive global quantum science community."

Broad, multinational support for IYQ signals the need to strengthen the education, research, and development capacities of governments — especially those of low- and middle-income countries — to advance quantum science and technologies for the benefit of humanity. The U.N. proclamation stands as an open invitation for anyone to learn more, especially those at universities, in K-12 classrooms, and other venues for science communication.

Throughout 2025, the IYQ consortium will organize regional, national, and international outreach events, activities, and programming to celebrate and develop learning resources for quantum science, build scientific partnerships that will expand educational and research opportunities in developing countries, and inspire the next generation of diverse quantum pioneers.

African Physics Newsletter Celebrates Five Years

The African Physics Newsletter, a free quarterly publication featuring physics news from across Africa, has reached a significant milestone: five years of publication with APS.

The newsletter debuted in 2019 and highlights stories on topics spanning from scientist profiles to renewable energy initiatives to new research articles. By reporting on stories across the continent, it aims to foster connections among physicists residing in Africa, diaspora communities, and the broader physics community.

The newsletter also helps fill a gap in news-sharing on physicists and physics institutions across Africa, a gap identified in part by surveys conducted by the Physics in Africa project, a collaboration by several global physics organizations.

Today, issues are produced by an editorial board of African physicists and supported by an advisory board. Stéphane Kenmoe, a researcher at the University of Duisburg-Essen in Germany, serves as the current editor in chief.

You can learn more about the newsletter or read the latest issue at go.aps.org/3yPsg2z.

BACK PAGE

Why Interdisciplinary Research Deserves Your Attention

Centuries ago, all scientists were interdisciplinary. We can learn from that approach today.

BY JESSICA THOMAS

A few years ago, I gave a talk at a university's physics department about my "alternative" career. I was the editor for a physics magazine, and I frequently got requests to explain how — and why — I left active research.

After the talk, my host leaned on the podium and, with eyebrow raised, said, "So, you traded depth for breadth?" He was right: I was happier knowing a bit about many topics than a lot about just one. Seeing the connections between research — from the impossibly fine precision of nanotechnology to the mysteries of dark matter — made me feel closer to science, and it was one of the reasons I left what had become an overly specialized science career.

I'm sharing this story because it explains why I find interdisciplinary research so attractive. Whether you think of it as applying the tools of one field to understand another, or discovering problems that only live at the boundaries of different fields, there's a need to think broadly, see a problem from multiple angles, and collaborate. You can't get locked into a narrow view. Instead, diverse scientific perspectives need to work seamlessly together.

The challenges facing us are too complex to solve with a single viewpoint. Look, for example, at the National Academy of Engineering's "Grand Challenges" list: making solar energy economical, advancing health informatics, developing carbon sequestration methods, and more. Not a single one could be solved within one discipline. One of the biggest research funding agencies in the U.S. — the National Science Foundation — prioritizes interdisciplinary work, noting that "support of interdisciplinary research and education is essential for accelerating scientific discovery and preparing a workforce that addresses scientific challenges in innovative ways."

Specialized, field-specific research is, of course, still essential. Without that specialist focus, we wouldn't have the knowledge base to tackle big problems. The ideal interdisciplinary team of the future will need to have a mixture of these specialists and researchers who can build connections between them. That connector-builder is a special skill because you need to speak the languages of many fields and ask questions that pull people into new ways of thinking.

Another reason to champion interdisciplinary research is that it can prepare students for fulfilling careers in various sectors of the workforce. Interdisciplinary research is inherently relatable, and that simple fact can be a compelling reason to choose science as a profession. Returning to the grand challenges list, you see things like making better medicines, understanding the brain, or improving how we learn. These are problems that matter to humans, and solving them can be a fulfilling career.

And careers in various sectors are increasingly valuing interpersonal skills like communication, collaboration, and team building. In recent years, close to a third of U.S. physics Ph.D.s who remained in the U.S. went into the private sector within a year of earning their doctorates. Large fractions of Ph.D.s in other science and engineering fields are finding jobs in the private sector as well. Working within an interdisciplinary team trains you to think broadly and collaboratively — desirable skills wherever you work, and especially valued in the private sector. Encouraging those skills through interdisciplinary projects at the graduate school level allows universities to better prepare their students for their careers.

I love physics because it trains you to simplify complicated problems to their essence. That simplifying mindset is an asset. But the joke about physicists is that they sometimes take the simplification too far — using a sphere to model a porcupine. Meaningful approaches to solving a problem require the expertise of environmentalists, biologists, doctors, engineers, and so on to know where that simplifying is okay and where it's not. For a physicist, that means learning not only a new language but even a new mindset about how to add detail to theory.

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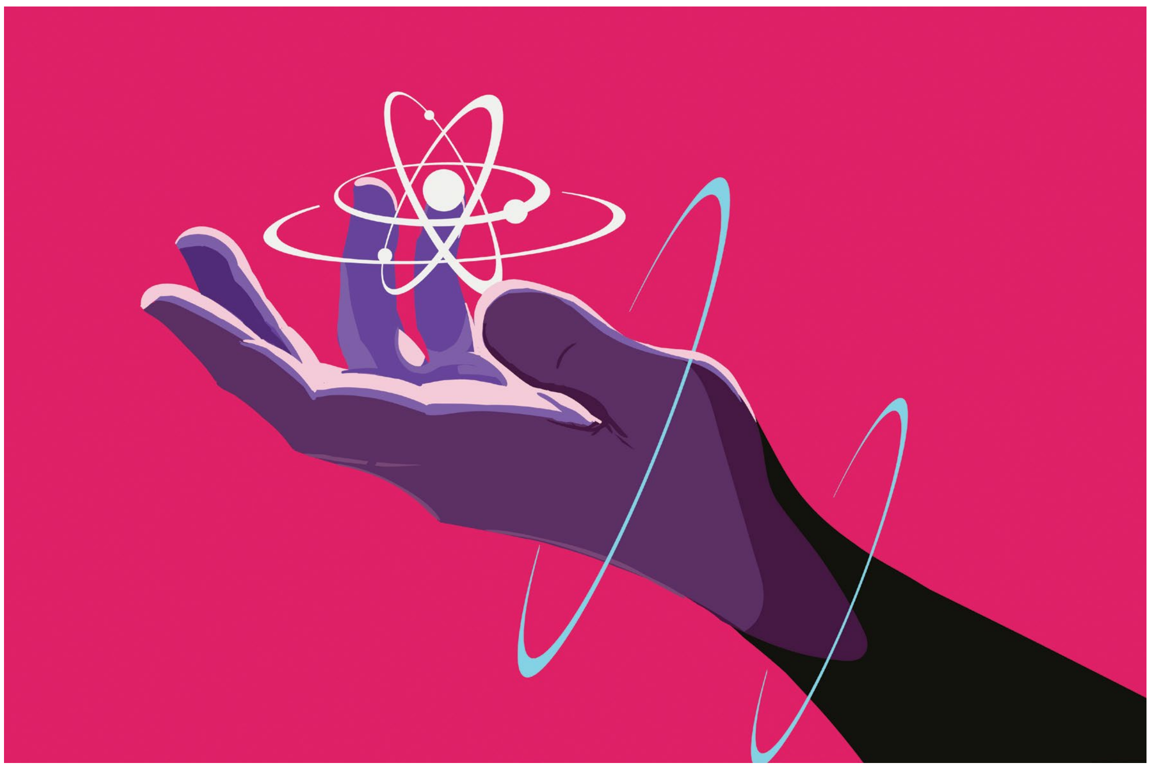
We see that intersection occurring at the interface between physics and biology. Traditional areas of physics — like mechanics, collective motion, complexity, statistical physics, and fluid dynamics — are merging with fundamental questions in biology, like cell migration, cell motility, epidemiology, and population dynamics. Universities and research labs are creating centers to support interdisciplinary work. At the American Physical Society, we launched a new journal, PRX Life, in 2023 to feature exactly that kind of research.

Another interdisciplinary avenue is the intersection of materials discovery with artificial intelligence. Researchers have nosed around for new materials for decades, using theory and intuition to identify the right blend and arrangement of atomic elements. They then painstakingly tweak the recipe. That approach led to high-temperature superconductors and the materials used in airplanes and lightweight batteries. Today, AI is able to predict hundreds of thousands of new materials at once — a scale far beyond what humans were able to do before. The people who predict and search for materials must work with those who know how to design and train these AI tools to fully take advantage of this new technology.



Finding research outside of your specialty isn't necessarily hard, but you have to make the time to look. One tip is to skip your department colloquium every once in a while for a seminar in another area. Science journalists also offer a lot of great stuff to read. The APS online magazine, Physics, makes a point of highlighting interdisciplinary research for its readers. All of the articles are free, and there's a mixture of easy reading and more in-depth analysis of new results.

Published research is easier to find now that more of it is available in open-access journals, which don't require a subscription to read. Two journals from APS — Physical Review X and Physical Review Research — offer exclusively open-access studies that cover all of physics and research that physics touches. Anyone can check out the cool stuff that editors have labeled "interdisciplinary physics" in PRX. The list includes new approaches to understanding cancer cells, climate, and animal behavior.

A thousand years ago, all scientists were interdisciplinary. Now, we're in a new era where specialists need to diversify. There's inertia to doing that because it means moving out of your comfort zone and often learning a new language and way of thinking. That's the challenge — and appeal — of working in any diverse group.

Jessica Thomas is the executive editor of the American Physical Society. From SWE Magazine ©2024. Reprinted with permission from the Society of Women Engineers.

Ph.D. Advisor continued from page 1

ing the right group would impact both their experiences as graduate students and their careers thereafter. "Your relationship with your [advisor] can make or break your career," said one student. As another student noted, the advisor would effectively oversee their lives for the next four or five years. And if it didn't work out, the only option might be to drop out. As a result, the students experienced anxiety about getting the decision right.

Despite the perceived importance of the decision, few of the students felt prepared to make it, citing little guidance from their professors or from their physics department. Students who struggled to find the right match expressed feelings of isolation or of worry that they were somehow failing before they had even started. Meanwhile, those who quickly found a group reported an increased sense of belonging.

The lack of support can lead students to pick a supervisor who is a poor fit — which studies, including the new one, have shown is particularly a problem for minority students. Verostek and his colleagues found that women and nonbinary students reported reduced research opportunities, as they perceived a lack of an inclusive culture in some of the research groups.

The situation is frustrating for those who strive for equity in the sciences, says Michelle Maher, an education researcher at the University of Missouri who has studied the Ph.D. advisor selection process for biomedical students. "It shouldn't be so difficult for students to navigate something that should be straightforward." Jackie Chini, an education researcher at the University of Central Florida, agrees. "We cannot continue to accept this as the status quo in physics," she says.

Being in the wrong group is known to cause students to feel like a failure and leave their Ph.D. programs, which is what initially happened to Verostek. After struggling to find a Ph.D. supervisor during his first year, Verostek ended up in a group that he quickly realized wasn't the right fit. Shortly thereafter he left. "It was a really hard decision," he says. "I was like, what am I going to do now?"

Verostek was later able to start over in a new group. But not everyone is so lucky. "There is an extremely high attrition rate for physics students leaving graduate programs," says Benjamin Zwickl, a physics-education researcher at Rochester Institute of Technology who worked on the study. One of the reasons that students may abandon physics is the difficulty of getting settled into a group, he says.

Both Verostek and Zwickl think that some of the problem could be alleviated relatively simply — by providing information on the process through easily accessible resources, such as department websites or graduate handbooks. In an analysis of the contents of graduate-student handbooks from 13 institutions, the team found that none provided guidance on how to search for and secure a supervisor. "There was nothing about when the process should start or how it should be carried out," Zwickl says. "Changing that is the low-hanging fruit."

Another option is to more consciously expose students to potential advisors or to let them rotate through various labs on a trial basis. This lab-rotation method often occurs in biomedical courses and has been shown by Maher and her colleagues to make the process of finding an advisor more structured. The students she followed were required to rotate through three labs during their first year, with the goal of picking one to stay in. "It didn't necessarily make the choice easier, but the process was predictable."

Zwickl would like to see lab rotations added to first-year-physics graduate courses. "Not all students have had access to research opportunities as undergraduates," he says. A short-term lab experience would give these students a better sense about what they would be doing in different groups. Zwickl notes that visiting labs and meeting experienced graduate students would also foster community and belonging, both of which are key for a positive Ph.D. journey.

Katherine Wright is the Deputy Editor of APS's Physics Magazine, *from which this article is reprinted.*